Homofermentative versus heterofermentative lactic acid bacteria
An evaluation of their use as silage starters

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Introduction:

The primary purpose of ensiling is the conservation of forage for feed (McDonald et al. 1991). However, silaging could be applied as a first step to produce chemicals from green biomass. Therefore it is important to select suitable bacteria for an inoculum. Using the knowledge about the product formation of different lactic acid bacteria may help to improve the output in the concept of the green biorefinery.

The objective of the present study was to investigate the effects of using several homofermentative and heterofermentative lactic acid bacteria strains in the fermentation process of ensiling. Detailed information about the mode of action of distinct single lactic acid bacteria strains in silage making should be collected. At the end the increased knowledge about the characteristics of the differing bacteria strains should be used for finding optimal single strains or mixtures of lactic acid bacteria to be used in silage treatment.

Investigations and Results:

Single strains were used as inoculum for grass or whole crop maize silage in laboratory scale.

Table 1: Fermentation patterns in laboratory silage inoculated with three different strains within 74 days of incubation.

P	**FT [d]**	**0**	**1**	**4**	**7**	**39**	**74**	**0**	**1**	**4**	**7**	**39**	**74**
		Control						***Lactobacillus plantarum* – IFA 626**					
G	[g/100g DM]	3,37	3,09	1,17	0,49	0,03	0,03	3,37	2,81	0,19	0,03	0,12	0,14
LA	[g/100g DM]	0,10	0,35	1,96	2,78	4,33	4,29	0,10	0,84	3,96	4,54	4,41	3,54
AA	[g/100g DM]	0,09	0,25	1,11	1,33	1,56	1,65	0,09	0,28	0,59	0,82	1,09	0,90
1,2-PD	[g/100g DM]	0,02	0,00	0,00	0,01	0,00	0,01	0,02	0,00	0,00	0,00	0,00	0,01
WSC	[g/100g DM]	_	5,51	3,14	1,14	0,69	0,83	_	3,36	3,63	1,43	1,24	1,33
pH		5,56	5,43	4,22	4,13	3,86	3,81	5,56	5,46	4,02	3,95	3,85	3,86
DM	[g/100g FM]	38,3	39,2	37,8	38,0	39,6	37,8	38,3	39,9	37,1	38,6	39,5	37,8
		***Lactobacillus brevis* – IFA 615**						***Lactobacillus buchneri* – IFA 550**					
G	[g/100g DM]	3,37	2,82	0,05	0,02	0,00	0,02	3,37	3,28	0,09	0,04	0,01	0,03
LA	[g/100g DM]	0,10	0,86	2,82	2,75	3,61	2,61	0,10	0,49	2,75	2,66	0,39	0,14
AA	[g/100g DM]	0,09	0,50	1,18	1,51	3,53	2,86	0,09	0,33	1,39	2,09	5,85	5,53
1,2-PD	[g/100g DM]	0,02	0,00	0,00	0,00	0,00	0,00	0,02	0,00	0,58	1,73	2,72	1,16
WSC	[g/100g DM]	_	4,72	1,10	0,70	0,71	0,76	_	6,28	2,02	1,15	0,80	0,65
pH		5,56	5,54	3,90	3,94	3,91	3,86	5,56	5,50	4,00	3,95	4,31	4,11
DM	[g/100g FM]	38,3	39,1	37,5	37,3	38,1	36,8	38,3	38,9	36,9	37,9	37,0	36,2

P...products, FT...fermentation time, G...glucose, LA...lactic acid, AA...acetic acid, 1,2-PD...1,2-propanediol, WSC...water soluble carbohydrates, DM...dry matter

For homofermentative species several *Lactobacillus plantarum* strains, two *Lactobacillus rhamnosus* and one *Pediococcus pentosaceus* were examined. All these strains led to a similar fermentation in the silages. A fast production of lactic acid took place and resulted in a rapid pH drop. These described properties of the homofermentative lactic acid bacteria species were reported in various work before, and are known to give an efficient silage fermentation with a product of high quality (Mayrhuber et al. 1999).

Several *Lactobacillus buchneri* strains, five *Lactobacillus brevis* and two *Lactobacillus reuteri* were investigated in the group of heterofermentative lactic acid bacteria as silage additives.
A number of laboratory silages treated with various *L. buchneri* strains were examined. The fermentation patterns were similar for all *L. buchneri* strains. Right from the beginning, the provided sugars were degraded, lactate and acetate were produced. After complete consumption of the sugars, the bacteria converted the lactic acid to acetate. In later stages of silage fermentation it was found that the lactic acid was degraded completely and therefore high amounts of acetic acid were accumulated. Parallel to the acetic acid some 1,2-propanediol was formed (Holzer 2001).
As a second heterofermentative group *Lactobacillus brevis* strains were investigated. Like for the *Lactobacillus buchneri*, *L. brevis* started to produce lactic acid and acetic acid right from the beginning of the fermentation. The difference between these two species was that the *Lactobacillus brevis* strains could not degrade lactic acid to acetic acid. Therefore lactate and acetate were produced to a certain value till no sugars were remaining. The acid concentrations reached did not change a lot in the final period of the ensiling process. Another difference was that no 1,2-propanediol was formed. In silages inoculated with *Lactobacillus reuteri* some acetic acid and ethanol was detected. However, 1,2-propanediol was not detected.

Conclusions:
With this work it could be demonstrated that by using selected species of lactic acid bacteria in silage fermentation the resulting product formation can be influenced leading to various important substances.

References:
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